



MARKSCHEME

May 2009

BIOLOGY

Higher Level

Paper 3

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Subject Details: **Biology HL Paper 3 Markscheme**

Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 × 20 marks**].

Maximum total = [**40 marks**]

1. A markscheme often has more marking points than the total allows. This is intentional. Do **not** award more than the maximum marks allowed for part of a question.
2. Each marking point has a separate line and the end is signified by means of a semicolon (;).
3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.
4. Words in brackets () in the markscheme are not necessary to gain the mark.
5. Words that are underlined are essential for the mark.
6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.
7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing **OWTTE** (or words to that effect).
8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF** (error carried forward).
10. Only consider units at the end of a calculation. Unless directed otherwise in the markscheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover page.

Option D — Evolution

- D1.** (a) $\frac{790-570}{570} \times 100; = 39\%;$ **[2]**
(Accept answers between 37–41% with the corresponding correct calculation. No marks if just difference (790–570) calculated.)
- (b) from earlier periods less fossil evidence available;
 because of more niches available at lower sea temperature / species spreading over greater depth/they evolved so more species/more time for adaptive radiation (speciation);
 modern classification methods recognize more species than previous methods;
 more research done at greater depths; **[2 max]**
- (c) valve length increases over time while average sea temperature decreases / there is an inverse/negative correlation between shell size and sea temperature;
 evolution of new species was slow up to approx. 5 million years ago when sea temperature was highest / evolution of new species was faster in last 5 million years when sea temperature was lower;
 depth of habitat not assessed for extinct species;
 conclusions unreliable because of lack of data from earlier time periods /
 conclusions unreliable because temperature relatively constant between 30 and 10 million years ago but the range of valves varies by about 100 µm; **[3 max]**
- D2.** (a) non-living synthesis of simple organic molecules;
 assembly of (simple organic) molecules into polymers;
 origin of self-replicating molecules that made inheritance possible;
 packaging of molecules into membranes with an internal chemistry different from their surroundings; **[1 max]**
- (b) initial atmosphere contained no free oxygen / anaerobic bacteria perhaps the first organisms on Earth;
 some prokaryotes were chloroplast-like/photosynthetic/cyanobacteria;
 oxygen is by-product of photosynthesis/oxygen produced by photolysis of water; **[2 max]**

- D3.** (a) speciation is the formation of a new species by the splitting of an existing species;
 allopatric speciation caused by geographical separation;
 sympatric speciation occurring within the same habitat caused by different niches
 / caused by courtship/feeding differences/behavioural differences;
 both processes lead to isolation of sub-populations;
 isolation favours certain genetic variations (within a species);
 over time this leads to genetic barriers/speciation; **[4 max]**
Both allopatric and sympatric speciation must be mentioned. [3 max] if only one mentioned.
- (b) all organisms have DNA as the genetic material;
 all organisms use (approx.) 20 different (L) amino acids;
 genetic code is (nearly) universal;
 mechanism for protein synthesis is similar;
 metabolic pathways are similar;
 if parts of DNA (genes) are shared between organisms then it denotes (close) relationship;
 the greater the percentage of genes shared, the closer the genetic relationship;
 mitochondrial DNA is maternally inherited in most organisms/phospholipid membranes/ATP common in most (all) organisms;
 conserved genes have similar function; **[6 max]**

Option E — Neurobiology and behaviour

- E1.** (a) bees with previous exposure/experimental group fly around the source more than the control group;
 bees with previous exposure/experimental group fly towards the source more than the control group;
 bees with previous exposure/experimental group circle more than the control group;
 in bees with previous exposure, orientated flight is greater than circling; **[2 max]**
Accept vice versa statements.
- (b) the bees associate the odour with food, and this is learned/conditioning behaviour **[1]**
Do not accept taxis or simply learned behaviour or conditioning.
- (c) previous exposure leads bees to fly to food source more directly;
 giving them an advantage in finding food;
 increasing their chance of survival;
 and passing their genes to the next generation;
 less energy expended finding food;
 more direct flight/less flight time reduces chance of predation; **[3 max]**
- E2.** (a) A – pinna
 B – eardrum/ tympanic membrane
 C – bone of middle ear / stapes/stirrup/ossicles/oval window
 D – semicircular canal **[2]**
Award [1] for every two correct labels – four correct labels required for [2].
- (b) (i) reflex is a rapid unconscious/involuntary response **[1]**
Answer must include either unconscious or involuntary.
- (ii) benzodiazepines / alcohol/ethanol / THC **[1]**
Two needed for [1].

- E3.** (a) place the invertebrates/animals in a controlled environment;
observe the behaviour to see which stimuli elicit a response;
choose one stimulus that appears to change behaviour;
ensure that other factors do not have an effect on the response;
state an appropriate method to measure the response;
ensure sufficient numbers of trials/animals to ensure reliability of data;
ensure that ethical standards are met; **[4 max]**
Full marks could be obtained by describing an experiment using a named organism e.g. woodlice.
- (b) it records changes in blood flow;
active parts of the brain have increased blood flow;
but not all brain activity is detected by MRI;
a subject is given a stimulus which is designed to stimulate brain activity;
links stimulus with certain part of the brain;
brain activity visualized by coloured images;
degree of activity can be represented (by different colours);
temporal activities can be recorded as well;
allowing sequential use of the brain to be visualized;
collaboration between brain parts;
non invasive; **[6 max]**

Option F — Microbes and biotechnology

- F1.** (a) $(12 \text{ dm}^3 \times 500 \text{ mg dm}^{-3}) = 6000 \text{ mg}$ **[1]**
- (b) (i) at approx. 50 days into the experiment there is a decline in the removal percentage;
removal percentage stable for most of the experiment / at nearly 100 %;
decrease in removal percentage linked to increase in teraphthalate outflow concentration/they are inversely related; **[2 max]**
- (ii) bacterial seeding culture has a lag phase;
bacterial culture has to adapt to reactor; **[1 max]**
- (c) chemoheterotroph **[1]**
- (d) removal is close to 100 % over the course of the experiment;
at the highest teraphthalate concentration removal is 100 %;
despite increasing teraphthalate inflow concentration, its concentration in the outflow is close to 0 mg dm^{-3} ;
so removal is very efficient; **[2 max]**
- F2.** (a) *Rhizobium*: nitrogen fixation / N_2 to NH_3
Nitrosomonas: nitrification / NH_3 to NO_2^- **[1]**
Both required for [1].
- (b) main ingredients are salt, soybeans, and water;
(crushed) mixture treated with *Aspergillus oryzae*;
carbohydrate/starch is broken down to glucose/lactic acid/ alcohol;
proteins broken down to peptides and amino acids;
fermented for 6–8 months; **[2 max]**

- F3.** (a) a virus is a non-cellular structure;
viruses consist of a protein coat and genetic material;
genetic material can be DNA or RNA;
may be ds or ss;
some are +/- RNA viruses;
some viruses are covered in a membranous bilayer/enveloped capsid/naked capsid;
some viruses/retroviruses have a reverse transcriptase component; **[4 max]**
- (b) pandemic is a widespread epidemic affecting large geographical areas (such as continents);
may be caused by a single mutation in the pathogen;
to which humans have no/reduced immunity;
virus/bacterium may mutate and cross the species barrier;
frequent contact between humans and animals is a necessity;
RNA viruses more prone to mutations;
reverse transcriptase is prone to production of mutations;
spread/infectivity by droplets/other bodily fluids;
link between economically developing countries and origin of pandemics;
link between economically developed countries and origin of multiple resistant bacteria;
longer incubation time lowers chance of detection and enables spread;
high density of population facilitates spread;
modern travel makes spread fast and efficient; **[6 max]**

Option G — Ecology and conservation

- G1.** (a) $45 \text{ trees} \times 10^{-1} \text{ hectare}^{-1} / 4.5 \text{ trees hectare}^{-1} / \text{per hectare}$ (*units required*) **[1]**
 (Accept answers in the range $41\text{--}47 \text{ trees} \times 10^{-1} \text{ hectare}^{-1}$)
- (b) total number of small trees is lowest furthest from the main road;
 from 1–4 km number of trees 5–10 / 2–5 cm fairly stable;
 number of trees 10–25 cm highest 1 km from main road; **[2 max]**
- (c) small tree density generally declines (but with an increase at 4 km);
 drop in density of small trees furthest from the main road; **[1 max]**
- (d) distribution of small trees similar between Katavi National Park and Usevya Open Area;
 Katavi National Park – no logging so has more large trees;
 Usevya Open Area (at 5 km from road) distance too great for logging of trees;
 small tree density in both areas low because number of large trees is higher/
 highest small tree densities near the road;
 no information given on density of large trees; **[3 max]**
- G2.** (a) the total dry mass of organic matter in living organisms/ecosystems **[1]**
- (b) UV radiation may cause damage to nucleic acids/proteins/lipids;
 give rise to increase in skin cancer rates/glaucoma/cataracts/skin ageing;
 may negatively affect plant/phytoplankton productivity;
 small amount beneficial *e.g.* vitamin D synthesis;
 used to kill microbes/water purification;
 used to treat jaundice in newborn infants; **[2 max]**

- G3.** (a) biomagnification is a process in which chemical substances become more concentrated at each trophic level;
certain toxins will accumulate in the body;
fat soluble toxins have a longer half life/will accumulate in body tissues;
examples are: DDT/TBT/organophosphates/mercury/other;
effects of toxins can be magnified up the food chain;
top predators/consumers/carnivores have highest concentrations stored in their body;
For named example include:
source of toxin *e.g.* TBT anti-fouling paint used on ships;
how it enters food chain *e.g.* taken up by filter feeders;
links in food chain;
effect on top consumer;
ecosystem/community affected;

[5 max]

- (b) K-strategists require more resources;
are long-lived;
are large, therefore need large habitats;
slow maturation, therefore require longer protection from predators;
more care for offspring / small number of offspring;
require stable habitat;
usually have stable population size;
perform better in an environment with high levels of competition/no vacant niches;
examples are: elephants / parrots / whales / Arctic tern / tortoise / other correct example;

[5 max]

Option H — Further human physiology

- H1.** (a) (i) $\frac{3.6-0.6}{0.6} \times 100 = 500\%$ [1]
- (ii) increased anaerobic respiration at high altitude/4300 m due to low partial pressure of oxygen [1]
- (b) glucose concentration starts to fall after the start of the exercise then levels off/decrease slows down/ glucose drops from 5.35 mM to 4.65 mM;
lactate concentration increases then levels off/then decreases/ lactate increase from 0.4 mM to 1.9 mM;
changes in lactate are the inverse of those in glucose; [2 max]
- (c) initial glucose concentration was lower at high altitude / glucose concentration increases only slightly/stays level (during exercise) at high altitude;
lactate concentration rises more sharply at high altitude / but initial concentration of lactate was similar;
less efficient use of glucose under anaerobic conditions / sharper increase in lactate concentration caused by increase in anaerobic metabolism; [3]
- H2.** (a) active transport: against concentration gradient and requires ATP and protein pumps/transport proteins;
facilitated diffusion: along concentration gradient, is passive/no ATP required and requires carrier/transport proteins;
simple diffusion: passive/no ATP required and along concentration gradient and through protein channels;
endocytosis: invagination of the cell membrane making a vesicle; [2 max]
- (b) *Two of the following needed for [1].*
cellulose/fibres
lignin
bile pigment
bacteria
intestinal cells [1 max]

H3. (a) *Named factors correctly outlined.*

genetic – some people predisposed for high cholesterol levels / high blood pressure;

age – older people greater risk / less elasticity in arteries;

sex – males at greater risk of heart disease than (pre-menopausal) women as estrogen protects against heart disease;

smoking – constricts blood vessels / increases blood pressure/heart-rate / decreases oxygenation of heart muscle;

diet – increased fat/cholesterol/LDL in blood leads to plaque formation in arteries;

exercise – helps reduce high blood pressure / exercise reduces the rate of fatty deposits building up in the inner lining of arteries/thickens the heart muscle walls so they pump blood more efficiently;

obesity – increase in blood pressure / leads to plaque formation in arteries; **[5 max]**

Accept any other factor with brief account e.g. diabetes, atherosclerosis.

Do not award a mark for the name of a factor and simply that it leads to CHD.

(b) *H. pylori* is a bacterium which causes gastritis;

stomach ulcers are open sores in the stomach wall;

prolonged presence of ulcers may lead to the formation of tumours;

cancer of the stomach is a malignant tumour in the stomach wall;

about 80 % of gastric ulcers are caused by *H. pylori*;

H. pylori survives in the stomach mucosa;

producing urease;

which neutralizes gastric acid;

colonization by *H. pylori* opens up/weakens the (protective) (mucosal/mucus) lining;

for digestive attack by gastric acid/HCl causing ulcers;

linking *H. pylori* to stomach ulcers was a paradigm shift in medicine;

cause was previously thought to be stress/lifestyle/diet;

H. pylori now thought to be primary cause / now treated as infectious disease; **[5 max]**